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Engelmann Spruce

Forest Service

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ENGELMANN SPRUCE

(*Picea engelmanni*)

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Engelmann spruce grows at high elevations in the mountain ranges in the western part of the United States and Canada. Its latitudinal range extends from Yukon Territory in Canada southward along the Rocky Mountains for approximately 3,000 miles to the Mexican border. Engelmann spruce generally occurs in the forest in mixture with other species. These mixed stands, in which Engelmann spruce frequently predominates, are common throughout the Rocky Mountains. They occur close to timber line and at the headwaters and along the upper courses of mountain streams, where the abundant soil moisture that Engelmann spruce requires for satisfactory growth is available. High mountain forests such as these serve a very important purpose in conserving water and regulating stream flow by retarding the melting of snows and run-off from rain, and also in protecting the soil from drying out and erosion.

The rate of growth of Engelmann spruce varies from extremely slow, under the very adverse conditions close to timber line, to fairly rapid under favorable conditions, especially in the northern part of its range. It is a long-lived species, reaching an age of 400 years or more. Individual trees occasionally attain a diameter of 5 feet and total height of 150 feet. The amount of Engelmann spruce of sawtimber size is approximately three times that of the combined stand of the eastern spruces,[1] but much of it is comparatively inaccessible.

The wood of Engelmann spruce is light in weight, soft, and weak. It closely resembles the wood of the eastern spruces in appearance and properties and, like them, is an excellent pulpwood. It is cut in small quantities, largely for local consumption, in places where the preferred woods, such as ponderosa pine and Douglas-fir in the Southwest and western white pine farther north, are not available and is used principally for construction lumber and boxes.

Nomenclature.—Englemann spruce is the name commonly used. Other names are white spruce, mountain spruce, Arizona spruce, silver spruce, and balsam.

Distribution and growth.—The range of Engelmann spruce in Canada extends from the southern part of Yukon Territory southward through the mountains in the provinces of British Columbia and Alberta. In the United States Engelmann spruce grows along the upper slopes of the Cascade Mountains in Washington, Oregon, and the extreme northern part of California, and in the Rocky Mountains in northeastern Washington, northeastern Oregon, Idaho, Montana, Wyoming, Colorado, Utah, Arizona, and New Mexico (fig. 1).

In Canada and the northwestern part of the United States, Engelmann spruce generally grows between elevations of 2,500 and 6,000 feet above sea level. Farther south it is found at increasingly higher altitudes. In Colorado, its altitudinal range extends from approximately 9,000 to 12,000 feet. The elevations at which it grows, however, not only in Colorado but also in other regions, may vary considerably with local climatic factors.

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[1] Includes red spruce (*Picea rubra*), black spruce (*Picea mariana*), and white spruce (*Picea glauca*).

Engelmann spruce requires abundant soil moisture for satisfactory growth and is generally found in the mountains near timber line and farther down along the banks of streams fed from melting snows. It grows in all kinds of stands, varying from those near timber line that contain a few scattered trees to those at lower elevations that consist of unbroken, dense forests. It seldom occurs in pure stands. Close to timber line, Engelmann spruce often grows in mixture with alpine fir and in the southern part of its range also with corkbark fir. Lower down, it may be associated with lodgepole pine and at still lower elevations with Douglas-fir. Many other species occur in mixture with Engelmann spruce at the lower limits of its growth, especially in northern Montana and Idaho.

Engelmann spruce timber of merchantable size and form is found at the intermediate and lower elevations. Trees at timber line are commonly stunted and may be 200 years old and only a few feet high and less than 5 inches in diameter. The amount of merchantable lumber that can be cut from typical stands containing Engelmann spruce varies from practically nothing at timber line to 80,000 board feet per acre on the best sites. Engelmann spruce may make up over one-half of this volume.

The tree is a prolific seeder and the seed have a high rate of germination and persistent vitality. The seedlings grow slowly unless they have an abundance of light—a condition which is frequently lacking in the uneven aged stands where the species generally occurs. Engelmann spruce is more tolerant of shade than most of its associates, and the mountain forests within its range commonly contain Engelmann spruce of all ages and sizes varying from seedlings to mature timber.[2] Seedlings and young trees that have endured long suppression under shade will recover rapidly and make good growth when the shade is removed.

Engelmann spruce generally grows more slowly in the southern part of its range. Measurements made on typical trees in stands grown under rather unfavorable conditions in Colorado and Utah show the following: Age 40 years—height 6.2 feet, diameter 0.8 inch; 80 years—height 16 feet, diameter 4.3 inches; 120 years—height 43 feet, diameter 7.9 inches; 200 years—height 75 feet, diameter 13.7 inches. Under better conditions growth is considerably faster, especially farther north. Mature trees in good situations are generally from 80 to 100 feet in height and 18 to 36 inches in diameter.

The root system of Engelmann spruce is shallow but well developed. Mature trees have a number of large lateral roots not over 2 feet below the surface of the ground which may extend 20 feet or more from the trunk. This enables the tree to thrive on shallow soils, but makes it dependent upon superficial soil moisture and exposes the roots to injury from surface fires and the tree to windthrow. The thin bark is also easily injured by fire which spreads readily through the dead, dry inflammable lower limbs and not infrequently to the crown. Fortunately the season of high fire risk is comparatively short at the elevations at which Engelmann spruce grows. The tree is subject to occasional attack by the spruce budworm. In recent years, such attacks have caused considerable damage in several localities in the southern portion of its range.

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[2] Stands of uneven age when reasonably accessible lend themselves readily to the selection system of cutting, under which as much of the commercial lumber as may be desirable is removed from time to time, while the forest cover is preserved and the value of the forest in conserving moisture and regulating stream flow is maintained.

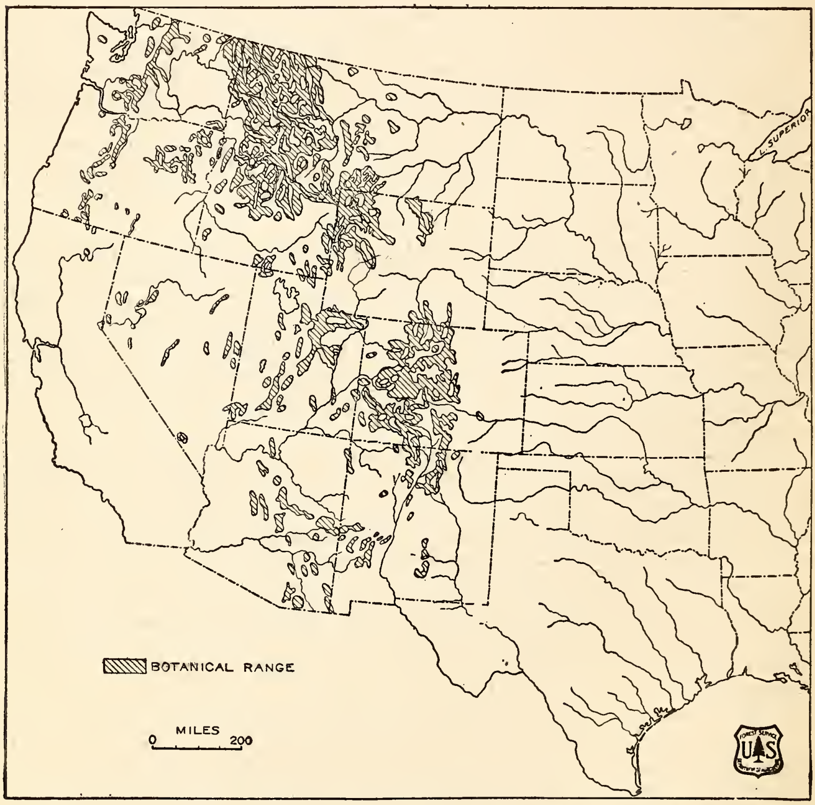

FIGURE 1.—Range of Engelmann spruce (*Picea engelmannii*) in the United States.

Supply.—An estimate in 1923[3] placed the stand of Engelmann spruce of saw-timber size in the United States at 30,678,156,000 board feet, distributed as follows:

	Board feet
Oregon	587, 530, 000
Washington	1, 220, 560, 000
Idaho	3, 650, 000, 000
Montana	4, 652, 000, 000
Arizona and New Mexico	1, 514, 329, 000
Colorado	13, 826, 961, 000
Remaining Rocky Mountain region	5, 226, 776, 000

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[3] Based on figures compiled by the Forest Service, U. S. Department of Agriculture, for a Senate Special Committee on Forestry.

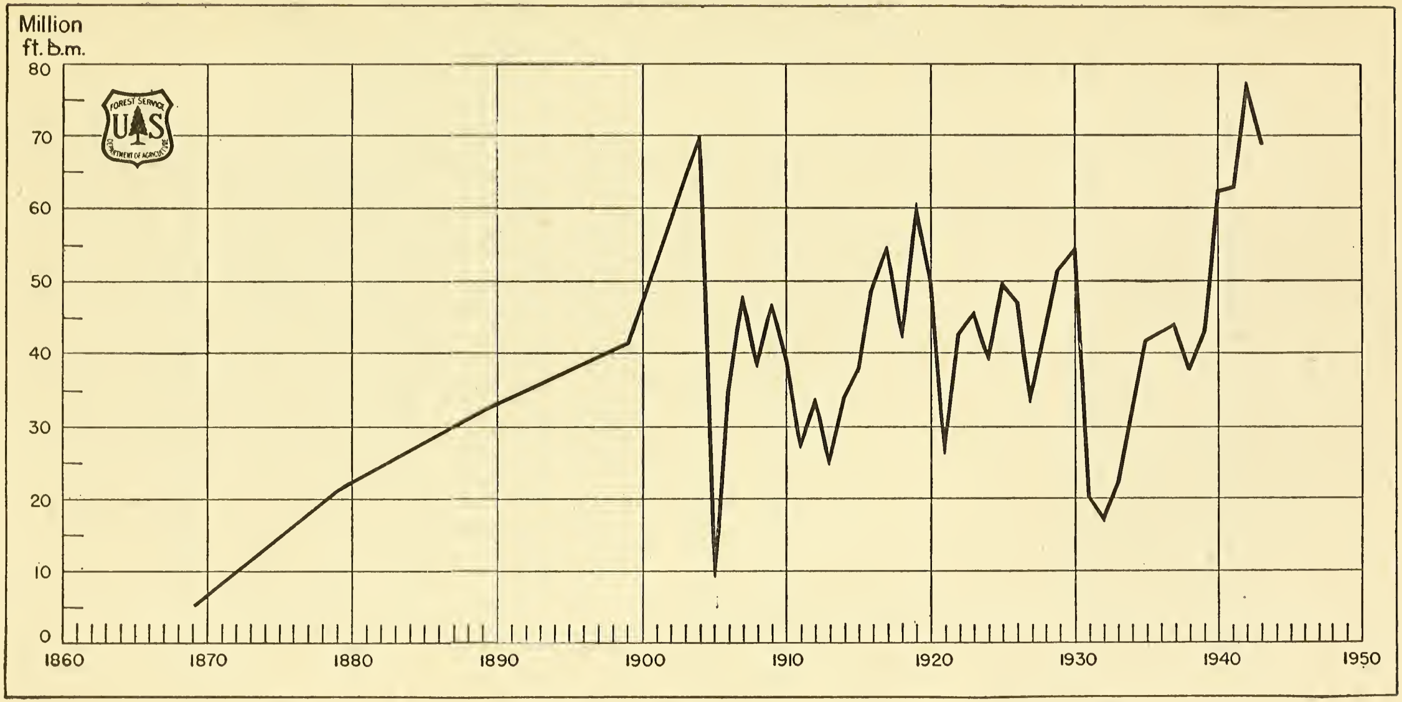

FIGURE 2.—Lumber production of Engelmann spruce (*Picea engelmannii*), 1869–1943.

This estimate also included 58,898,605,000 board feet for the stand of Engelmann spruce in British Columbia.[4]

An estimate made in 1937[5] gave the total stand of all the western spruces[6] of saw-timber size as 62,821,000,000 board feet. Nearly all of it was made up of Engelmann spruce and Sitka spruce. Recent forest surveys placed the total stand of Sitka spruce in the United States at approximately 13,500,000,000 board feet,[7] leaving a balance of about 49,300,600,000 board feet, of which at least 49,000,000,000 board feet is Engelmann spruce and the remainder largely blue spruce.

The following tabulation shows the stand of Engelmann spruce in Washington, Oregon, Montana, and Idaho according to the findings of recent surveys, and also the estimated stands in other States or groups of States within its range.

	Board feet
Washington:	
Western	[1] 39,100,000
Eastern	[1] 1,969,600,000
	2,008,700,000
Oregon:	
Western	[1] 217,300,000
Eastern	[2] 621,400,000
	838,700,000
Montana	6,116,000,000
Idaho	5,810,000,000
Colorado	[3] 22,000,000,000
Arizona and New Mexico	[3] 2,500,000,000
Wyoming, Utah, and Nevada	[3] 9,726,600,000
Total	49,000,000,000

[1] Andrews, H. H., and Cowlin, R. W. FOREST RESOURCES OF THE DOUGLAS-FIR REGION (table 52, p. 162). U. S. Dept. Agr. Misc. Pub. 389, 169 pp., illus. 1940.

[2] Cowlin, R. W., Briegleb, P. A., and Moravets, F. W. FOREST RESOURCES OF THE PONDEROSA PINE REGION (table 33, p. 93). U. S. Dept. Agr. Misc. Pub. 490, 99 pp. illus. 1942.

[3] The combined stand of Engelmann spruce in Washington, Oregon, Montana, and Idaho, according to recent surveys, was 14,773,400,000 board feet. Subtracting this amount from 49,000,000,000 board feet leaves a stand of 34,226,600,000 board feet to be distributed among Colorado, Wyoming, Utah, Nevada, Arizona, and New Mexico. If it is assumed that the relative size of the stands in these States is approximately the same as in the 1923 estimate, the amounts will be roughly as indicated in the tabulation.

Production of lumber.—The earliest figures showing the amount of lumber produced from Engelmann spruce are for 1869,[8] when the reported cut was 5,000,000 board feet (fig. 2). Production increased rapidly and 35 years later (1904) reached 70,000,000 feet. Since then production has varied widely. The maximum of approximately 78,000,000 board feet was reached in 1942. Production in 1943 was 69,048,000 board feet. The average annual cut for the 10-year period 1934–43 was approximately 50,000,000 board feet. This was made up of an average annual cut for the same period of about 16,600,000 board feet from Colorado, about 12,300,000 board feet from Montana, about 8,100,000 board feet from Idaho, and smaller amounts from the other producing States including Wyoming, Utah, Washington, and New Mexico. Colorado led in the production of Engelmann spruce lumber each year up to 1919, with Montana or Idaho second. During the period 1919–43 Montana led in annual production in 11 years scattered through the period, Colorado in 8 years, Idaho in 5 years, and Washington in 1 year.

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[4] Engelmann spruce does not grow in Alaska.

[5] Based on figures compiled by the Forest Service, U. S. Department of Agriculture, for the Joint Congressional Committee on Forestry.

[6] The western spruces include Engelmann spruce, Sitka spruce (*Picea sitchensis*), Western white spruce (*P. glauca* var. *albertiana*), blue spruce (*P. pungens*), and Brewer spruce (*P. breweriana*). Western white spruce and Brewer spruce occur in only small quantities and are of little commercial importance. They can be omitted from consideration in estimates of spruce stands. Blue spruce occurs in larger quantities than Western white spruce and Brewer spruce and finds some local use. Its stand, however, compared to the stands of Engelmann spruce and Sitka spruce, is very limited.

[7] Andrews, H. H., and Cowlin, R. W. FOREST RESOURCES OF THE DOUGLAS-FIR REGION (table 52, p. 162). U. S. Dept. Agr. Misc. Pub. 389, 169 pp., illus. 1940.

[8] Bureau of the Census.

Indeterminate amounts of Engelmann spruce are used for mine timbers, poles, railroad ties, and fuel, largely in the southern portion of its range. The average annual cut for all purposes in recent years is estimated at the equivalent of 55,000,000 board feet.

Properties.—The heartwood of Engelmann spruce is nearly white in color with a slight tinge of red. The narrow sapwood, generally from ¾ to 2 inches wide in trees of saw-timber size, is often difficult to distinguish from the heartwood but is commonly lighter in color. The annual growth rings are fairly distinct and are marked by the contrast in color between the summerwood and the springwood of the succeeding year. The transition from springwood to summerwood is gradual. The wood has a medium to fine texture. It is without characteristic taste or odor. Engelmann spruce contains resin ducts, but they are few in number and often visible only as white specks in the summerwood; their presence serves as a means of distinguishing the wood of Engelmann spruce from that of white fir [9] which normally lacks resin ducts but closely resembles Engelmann spruce.

The wood of Engelmann spruce is generally straight-grained, has a moderately small shrinkage, and can be readily air-dried with little tendency to warp or cup. When properly dried, it stays in place well. The wood is rated as light in weight,[10] weak when used as a beam or post, and it is limber, soft, and low in ability to resist shock.

In paint-holding properties Engelmann spruce is classed with ponderosa pine and western hemlock—below the white pines, cedars, redwood, and cypress, and above Douglas-fir and southern yellow pine. Engelmann spruce, together with Sitka spruce and the eastern spruces, is among the woods that glue easily under a wide range of gluing conditions. The wood [11] is not durable when used under conditions favorable to decay. In this respect it ranks with the hemlocks. The heartwood is difficult to penetrate with a preservative.

The lumber is quite likely to contain small knots formed by the numerous small limbs which persist for a long time even near the base of the tree, where they are in heavy shade.

Englemann spruce has excellent pulp and paper making properties, ranking in this respect with the eastern spruces (white, red, and black) long used in the manufacture of paper pulp. Engelmann spruce can be readily reduced to pulp by two chemical processes—the sulfite and the sulfate.[12] Both processes produce strong pulps of fine texture.

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[9] Also other western true firs.

[10] The average weight of the Engelmann spruce in an air-dry condition (12 percent moisture content) is 23 pounds per cubic foot. It is the lightest of the spruces.

[11] Applies to heartwood. The sapwood of all species lacks durability.

[12] Six processes are used commercially in making paper pulp from wood. One is the mechanical or ground-wood process, in which the wood is reduced to pulp on a grindstone. The yield approaches 100 percent of the weight of the wood. Four are chemical processes—the sulfite, sulfate, soda, and neutral sulfite. They depend upon the dissolving action of chemical reagents which remove essentially all of the binding material

The sulfite pulp has an excellent color and bleaches easily. Sulfate pulp probably also has satisfactory bleaching properties similar to those of white spruce. Sulfite pulp made from Engelmann spruce is suitable for the manufacture of news, wrapping, book, high-grade printing, and bond papers, and sulfate for high-grade kraft wrapping papers and fiberboard. Engelmann spruce also reduces readily by the mechanical process to yield a pulp of excellent color and standard strength suitable for practically all the uses requiring ground wood. The power required to operate the grinders when Engelmann spruce is pulped by this process is comparable to that required for white spruce.

Principal uses.—Engelmann spruce is used principally for lumber and in a limited way for mine timbers, railroad ties, and poles. Its use for mine timbers and railroad ties is confined largely to the southern Rocky Mountain States. A large proportion of the lumber goes into building construction and boxes. Much of it is used in the form of boards and dimension stock for subflooring, sheathing, and studding in construction that does not require material with a high degree of strength and stiffness. Engelmann spruce is one of the species used by a single pulp mill in eastern Washington.[13]

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under steam pressure. The yield of pulp is about one-half the weight of the wood. In a sixth process, the semichemical, part of the lignin is removed by chemical means, and the resultant pulp, containing some lignin, is further refined by mechanical means. The yield of semichemical pulp is intermediate between the yields obtained with the mechanical process and the chemical processes.

[13] A few shipments of Engelmann spruce pulpwood in the form of logs were made in 1939 and 1940 to a pulp mill in Wisconsin. The practicability of such long hauls has not yet been definitely determined. Another quite evident possibility for making use of large stands of Engelmann spruce for paper pulp is the establishment of additional pulping capacity in the northern Rocky Mountain region or in other regions of its growth. Discussions of such possibilities have centered around the production of bleached sulfite pulp for which a market could probably be found among the numerous paper mills in the Lake States whose supply of raw material from nearby sources has become more and more curtailed and higher and higher in price. This possible market for Engelmann spruce pulp can be reached, however, only by long and costly hauls. Nevertheless, it is true that there is a large amount of Engelmann spruce pulpwood available in varying degrees of accessibility. The practicability of using it depends on how badly it is needed due to the curtailment of former sources.

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